

GnRHa Before Single-Port Laparoscopic Hysterectomy in a Large Barrel-Shaped Uterus

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ABSTRACT

Background and Objectives: Laparoscopic hysterectomy for a large barrel-shaped uterus is difficult. We assessed the feasibility of single-port laparoscopic hysterectomy in a large barrel-shaped uterus after gonadotropin-releasing hormone agonist (GnRHa).

Methods: We retrospectively reviewed 39 patients with a large barrel-shaped uterus who were treated with GnRHa (leuprolide acetate) before single-port laparoscopic hysterectomy. During the same period, 134 patients without GnRHa pretreatment were included as control subjects.

Results: Patients with GnRHa treatment had an average increase in hemoglobin of 3.0 mg/dL and a decrease in uterine weight of 330.9 g (40.1%). Ancillary ports were required in 2 patients in the treatment group and none in the control group. There were no differences in uterine weights, operative time, and estimated blood loss in the 2 groups of patients. The estimated average operative time was shortened by 34 min after GnRHa treatment. However, bladder and ureter injuries were marginally higher (10.3% versus 2.2%) and days of hospital stay (3.7 versus 3.1) were significantly longer in the treatment group compared with controls. Complication rates were correlated with previous operative history, pelvic adhesion, and

larger uterine weight but not with GnRHa treatment and operative sequence.

Conclusions: GnRHa pretreatment in patients with a large barrel-shaped uterus during SPH is feasible with shortened operative time. However, the higher complication rates in these patients suggest that a weight-reduced barrel-shaped uterus that is achieved with GnRHa treatment could still be difficult and should be handled in cautious.

Key Words: Gonadotropin-releasing hormone agonist, Single-port, laparoscopic hysterectomy.

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The authors thank Tsuey-Hwa Hu for statistical assistance.

Disclosure: none.

Funding/Financial Support: none.

Conflicts of Interest: The authors have no conflicts of interest directly relevant to the content of this article.

Informed consent: Dr. Torng declares that written informed consent was obtained from the patient for publication of this study/report and any accompanying images.

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DOI: 10.4293/JSLS.2019.00019

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INTRODUCTION

Hysterectomy through laparoscopy is one of the most common gynecological surgeries and has become an alternative to the standard transabdominal hysterectomy. It is currently accepted as a safe and efficient method for managing benign gynecological disease because of the advantages of low complication rates and more rapid recovery.¹ In laparoscopic hysterectomy, single port hysterectomy (SPH) is an alternative to traditional multiport laparoscopic hysterectomy (MLH). This technique was modified and became more feasible in 2009.² SPH has less postoperative pain, better cosmetic outcome, similar complication rates, but longer operative time compared with MLH.³

Laparoscopic hysterectomy in a large uterus is difficult. With the use of MLH, increased uterine weights were associated with increased operative time, more intraoperative blood loss, longer hospital stay length, and greater postoperative complications.^{4–6} SPH in a large uterus is more difficult than MLH because the only route of trocar entrance is from the umbilicus. This entrance site could be completely obscured by a large uterus. Surgical approach could be even more difficult when the uterus is big and “barrel-shaped” such that the whole pelvic cavity was occupied by the uterus. The technical limitations of SPH, such as triangulations due to fulcrum effects, limitation of tissue retraction, crowding of instruments and inline vi-

sion, could make surgery under such conditions even more difficult.

Preoperative gonadotropin-releasing hormone agonist (GnRHa) treatment for women with uterine fibroids could reduce preoperative uterine and fibroid size and allow easier application of hysterectomy. Based on meta-analyses, GnRHa treatment before surgery could allow Pfannestial incision during traditional abdominal hysterectomy and increase the possibility of vaginal surgery.⁷ Application of GnRHa to allow easier performance of minimal invasive surgery is reasonable. However, the application of GnRHa treatment in large barrel-shaped uteri with the use of SPH has not been reported and could be challenging.

We started single port surgery in April 2011, and it became a standard procedure for all patients with benign gynecological diseases. In this study, we retrospectively reviewed all patients with large and barrel-shaped uteri who were intentionally pretreated with GnRHa before SPH. Patients who received SPH without GnRHa treatment during the same study period were matched with pathological diagnosis and were included for comparison. We calculated the decrease in uterine mass and shortening of operative time due to GnRHa treatment. We aim to study the feasibility of SPH in large barrel-shaped uteri after GnRHa treatment.

METHODS

After obtaining National Taiwan University Hospital Institutional Review Board approval (February 11, 2015, reference number 20150105252RINA), a retrospective chart review was initiated. From April 1, 2011, to March 30, 2016, patients with large and barrel-shaped uteri who received GnRHa treatment and SPH from a single surgeon (P-L.T.) were included. The inclusion criterion for using GnRHa treatment before surgery was having a large “barrel-shaped” uterus >18 gestational weeks but not more than 8 cm above the umbilicus. A “barrel-shaped uterus” was defined as a uterus with limited bilateral parametrial spaces (by pelvic examination) due to uterine masses that occupied the pelvic cavity. The judgment of limited bilateral parametrial spaces was based on the surgeon’s experience, such that these cases were potentially difficult for minimally invasive surgery. During the study period, patients who received laparoscopic hysterectomy without GnRHa pretreatment were matched with pathological diagnosis and were included as control subjects.

GnRHa (3.75 mg leuprolide acetate depot; Takeda, Rome, Italy) was given via intramuscular injection every 4 weeks. Three doses were suggested for each patient, but the exact amount of injections was altered depending on the patient’s condition and the available time of operation.

Ultrasound Measurement and Estimate of Uterine Weight

Ultrasound was performed to estimate uterine volume before GnRHa treatment and at 1 day before surgery. Abdominal or transvaginal sonography was performed by trained residents using a 7.5-MHz linear or a 3.5-MHz convex transducer on a Toshiba SSA-660A or 580A (Tokyo, Japan) ultrasound machine. Uterine size (length, width, and depth), myoma size, and myoma status including number, types (submucosal, intramural, subserous, or intraligamentous), and location (anterior, fundus, or posterior wall) were measured. Ultrasound records were rechecked (by S-P.P.), and an “M value” was given to each myoma based on the percentage of outward protrusion of myoma mass from the uterine surface. For example, a pedunculated subserosal myoma was assigned a value of 1, a subserosal myoma with 80% protrusion was assigned a value of 0.8, a subserosal myoma with 50% protrusion was assigned a value of 0.5, and so on. The M value for intramural myoma was set as 0. The sizes of the uterus and the myomas were added together, and the final volume was calculated by using the formula for an ellipsoid ($\pi/6 \times \text{length} \times \text{width} \times \text{depth}$). The weight of the uterus and myomas was then converted to mass units (g) by multiplying the assumed constant density for adipose tissue-free smooth muscle (1.04 g/cm³).⁸ The uterine and myomas weight calculated was then recorded as “ultrasound estimated uterine weight.”

Surgical Technique

Standard technique for the laparoscopic hysterectomy included uterine manipulator (Valtchev uterine mobilizer) placement in all cases. A 2- to 2.5-cm transumbilical incision was performed to set up a single-port equipment using either a wound retractor and a glove² or an SILSTM port (Covidien, New Haven, CT). A 30-degree, 5-mm camera and conventional straight instruments were used for SPH. Bilateral round ligaments were sealed and transected by using a LigaSure system (Valleylab, Boulder, CO). Fallopian tubes were removed in most cases with the use of LigaSure. Utero-ovarian ligaments were transected to preserve ovaries, or infundibulopelvic ligaments were transected to remove the ovaries. In cases with oophorectomy, the cystic lesions were sepa-

rated from the ovary and the bleeders on the ovarian tissue were carefully sealed without suture. Bilateral uterine arteries were sealed and transected with the use of LigaSure. Adhesiolysis was performed by blunt and sharp dissection if needed.

In LAVH, anterior colpotomy was performed via the laparoscopic route. A uterine specimen was removed from vagina with a scalpel or scissors. Ancillary ports were required in 2 cases to perform myomectomy using the technique of in situ morcellation⁹ via the use of a power morcellator (Gynecare; Ethicon Inc., Johnson and Johnson, Somerville, NJ) before the completion of laparoscopic hysterectomy. Stump closure was performed via the vaginal approach. In LSH, the uterus was transected at the endocervical portion via monopolar electrocauterization. The uterine specimen was removed from the umbilical wound by scalpel-based morcellation. Cervical stumps were closed via laparoscopic suture using barbed suture (V-Loc; Covidien, Mansfield, MA) in the first year of the study and later with Tisseel™ (Baxter International Inc., Deerfield, IL) application without suture. All of the removed uterus and myoma specimens were freshly weighed before fixation in formalin.

Chart Review

Charts were assessed for the following parameters: age at time of surgery, body mass index (BMI, calculated as weight in kilograms divided by the square of height in meters), and history of previous abdominal or pelvic surgery. Diagnosis was made based on pathological findings. During surgery, type of surgery with either LAVH or LSH, numbers of ports used, combined additional procedures, degree of adhesion during operation, and estimated blood loss (EBL) were recorded. Degrees of adhesion were defined as mild (avascular and easily lysed), moderate (easily lysed but bled at time of lysis), and severe (thick and requires extensive sharp dissection). Blood transfusions were performed when preoperative hemoglobin was < 9 mg/dL or when EBL was > 500 mL. Total operative time was defined as the time from the first skin incision to skin closure. Operative sequence was defined as the consecutive operative sequence from the first SPH.

After surgery, length of hospital stay, immediate intraoperative and postoperative complications such as blood transfusion, urinary tract injury, gastrointestinal tract injury, vascular injuries, postoperative fever, ileus, vaginal cuff dehiscence, and conversions were also recorded.

Statistical Analysis

Continuous variables are reported as mean and standard deviation, whereas discrete variables are reported as percentages of the total. All comparisons of continuous variables across cohorts were analyzed using a *t* test, and discrete variables were compared between groups using a χ^2 test. In the case of small cells, Fisher exact test was used. Statistical analysis was performed using Statistical Analysis System (SAS) version 8.0 (SAS Institute, Cary, NC). In all instances, a 2-tailed *p*-value of < .05 was considered statistically significant.

RESULTS

A total of 39 patients with GnRHa treatment and 134 patients without GnRHa treatment were included. The mean age of the 173 patients in the study population was 45.5 ± 4.9 (range 25 to 72) years, with mean BMI of 23.8 ± 3.8 (range 16.8 to 35.1) kg/m². Patients in the treatment group were significantly older and thinner compared with patients in the control group. Most of these patients were diagnosed with leiomyoma (**Table 1**).

Effect of GnRHa on Surgical Outcome

Table 2 shows the operative outcomes of the two groups of patients. No conversion occurred in all patients. There were no differences in operative weight, operative time, and EBL between the 2 groups of patients. Ancillary ports were required in 2 patients in the GnRHa treatment group. One patient had limited uterine size regression after 1 dose of GnRHa treatment but was scheduled for immediate surgery due to an intolerable side effect of GnRHa. The operated uterine weight was 1,409 g. The other patient had a huge intraligamentous myoma (11 cm largest diameter) that occupied the entire lower pelvic cavity and made the intraligamentous location of the myoma unrecognizable before surgery. It showed no regression after 3 doses of GnRHa. Ancillary ports were applied in both cases for in situ morcellation⁹ to remove the myoma before proceeding to LAVH. Both patients' courses were complicated with massive bleeding that required blood transfusion. The patient with intraligamentous myoma also had ureter injury that was noticed few days after the surgery. She underwent a second operation for ureteral reimplantation and was hospitalized for 20 d. In the control group, 1 patient was found to have adenomyosis with complete cul-de-sac obliteration. The operation was complicated with rectal perforation, which was repaired laparoscopically using Endo GIA™ (Covidien, New Haven, CT). Overall, patients in the treatment group had signifi-

Table 1.
Clinical Characteristics of the Patients

	GnRHa Treatment (n = 39)	Control (n = 134)	P value
Age, y	47.1 ± 3.8 (36–53)	45.0 ± 5.1 (25–72)	.02
BMI, kg/m ²	22.7 ± 3.1 (17.0–32.7)	24.2 ± 3.9 (16.8–35.1)	.03
Diagnosis			
Leiomyoma	25 (64.1)	48 (35.8)	.007
Adenomyosis	5 (12.8)	32 (23.9)	
Leiomyoma and adenomyosis	9 (23.1)	54 (40.3)	
Previous abdominal/pelvic surgery ^a			
Never	20 (51.3)	90 (67.2)	.10
Cesarean section	6	24	
Myomectomy	2	11	
Adnexal surgery	4	11	
Appendectomy	7	3	
Others (GI tract)	2	1	

BMI, body mass index; GnRHa, gonadotropin-releasing hormone agonist; GI, gastrointestinal.

Data are shown as mean ± SD (range) or n (%).

^aSome patients had multiple surgeries.

cantly longer period of hospital stay due to a marginally higher rate of urinary tract injury.

We analyzed the parameters related to complication rate and found pelvic adhesion, as well as uterine weight, operative time, EBL, and days of hospital stay, significantly correlated with higher complication rate. However, GnRHa treatment and operative sequence were not related to complication rates (Table 3).

Effect of GnRHa on Anemia, Uterine Size, and Operative Time

Anemia was defined as hemoglobin level of < 10 mg/dL due to menorrhagia, and 18 (46.2%) patients in the treatment group were anemic before treatment. The average number of GnRHa injection per patient was 3.2 ± 1.4 (range 1 to 7). After GnRHa treatment, 2 patients had massive vaginal bleeding that required blood transfusion before surgery (Table 1). After GnRHa treatment, the average increase in hemoglobin level was 3.0 mg/dL (Table 4).

Ultrasound was used to estimate uterine weight in each GnRHa-treated patient during 2 study periods: before GnRHa treatment and on the day before surgery. To validate the accuracy of ultrasound estimation, uterine weights measured immediately after surgery were compared with

the ultrasound-estimated uterine weights before surgery in the GnRHa treatment group. A strong positive linear correlation was found between the ultrasound-estimated uterine weight and the operated uterine weight (Figure 1). Before GnRHa treatment, 69.2% of the patients had an ultrasound-estimated uterine weight of > 500 g. After treatment, the estimated uterine weight was decreased by 40.1% (from an average 825.4 g to 494.5 g) (Table 4 and Figure 2). The percentage of operated uterine weight > 500 g was only slightly higher in the treatment group compared with the control group (39.1% versus 34.3%).

To calculate how much operative time could be shortened by GnRHa treatment, we plotted operative time against operated uterine weight and established a linear regression line between these 2 variables (Figure 3). From this regression line, the average estimated operative time was decreased by 34 min after GnRHa treatment.

DISCUSSION

Our study showed that SPH was feasible in large barrel-shaped uteri after GnRHa treatment. These cases were potentially inoperable with minimally invasive surgery before GnRHa treatment. After GnRHa treatment, the anemic condition for these patients was improved by 3 mg/

Table 2.
Operative Outcomes

	GnRHa Treatment (n = 39)	Control (n = 134)	P value
Type of operation			
LAVH	32 (82.1)	107 (79.9)	.94
LSH	7 (17.9)	27 (20.1)	
Combined additional procedures			
No ^a	37 (94.9)	111 (82.8)	.11
Salpingo-oophorectomy	0	8	
Oophorocystectomy	1	12	
Others	1	3	
Additional auxiliary port	2 (5.1)	0	.07
Degree of adhesion			
None	33 (84.6)	100 (74.6)	.28
Mild to moderated	3 (7.7)	18 (13.4)	
Moderate to severe	3 (7.7)	16 (11.9)	
Uterine weight, g	489.4 ± 263.1 (150–1409)	436.7 ± 247.1 (113–1523)	.25
Operative time, min	146.7 ± 61.3 (72–360)	149.0 ± 59.3 (72–390)	.83
Estimated blood loss, mL	223.1 ± 306.1 (20–1600)	258.0 ± 321.8 (20–2300)	.55
Hospital stay, days	3.7 ± 3.0 (2–20)	3.1 ± 0.9 (2–13)	.04
Complications	10 (25.61)	18 (13.4)	.12
Blood transfusion	7 (17.9) ^b	15 (11.2) ^c	.40
Urinary tract injury	4 (10.3)	3 (2.2)	.08
Bladder injury	2	1	
Ureter injury	2	2	
Gastrointestinal tract injury	0	1 (0.7)	.51

GnRHa, gonadotropin-releasing hormone agonist; LAVH, laparoscopic assisted vaginal hysterectomy; LSH, laparoscopic supracervical hysterectomy.

Data were shown as mean ± SD (range) or n (%).

^aFallopian tubes and ovaries that were removed without pathological lesions were denoted as no combined additional procedures.

^bTwo patients received blood transfusion before surgery and 1 patient received blood transfusion after surgery with urinary tract injury.

^cOne patient received blood transfusion after surgery with gastrointestinal tract injury.

dL, the uterine size was decreased by 40.1%, and the operative time was shortened by 34 min.

Laparoscopic operation in a large uterus is challenging even in experienced hands. Uterine weight at 250 g has been set as the cut-off value for longer operative time and greater blood loss in MLH.⁵ For uterine weight > 500 g, operation time was reported to be even longer,^{6,10,11} conversion rate was 3.4%¹⁰ to 13.5%,⁶ and the life-threatening complication rate was 0.7%.¹⁰ At uterine weight > 1 kg, the conversion rate was 4.2% to 9.7%, the mini-laparotomic incision rate to extract the uterus was 21%, and the

rate of complications, such as bladder injury, urinary retention, vaginal vault hematoma, and bowel herniation through a trocar port, was 11.4%, even in surgeons with a high level of endoscopic experience.¹² Recently, Ito et al. reported a conversion rate of 5.2% and a transfusion rate of 12.4% in 95 cases of minimally invasive hysterectomy in patients with a uterine weight of > 1 g.¹³ These results highlighted the difficulty of MLH in large uteri.

SPH is an alternative to MLH. Longer learning time may be necessary for SPH.¹⁴ However, randomized studies comparing SPH with MLH by experienced laparoscopists re-

Table 3.
Laboratory Characteristic and Estimated Uterine Weight Before and After GnRHa Treatment

	Before GnRHa (n = 39)	After GnRHa (n = 39)	P value
Hemoglobin, mg/dL	9.7 ± 2.6 (3.7–14.1)	12.7 ± 1.7 (6.9–15.3)	<.001
Number of myoma	3.1 ± 2.5 (1–10) (n = 34)	2.7 ± 1.7 (1–7) (n = 33)	.45
Dominant myoma size, cm	8.5 ± 2.6 (4–14) (n = 34)	6.8 ± 2.5 (3–12) (n = 33)	.008
≥0	14 (41.2)	5 (15.2)	.06
≥5 to 10	17 (50.0)	23 (69.7)	
<5	3 (8.8)	5 (15.2)	
Estimated uterine weight, g	825.4 ± 452.3 (241.8–2217.5)	494.5 ± 272.0 (135.4–1452.6)	<.001

GnRHa, gonadotropin-releasing hormone agonist.

Data are shown as mean ± SD (range) or n (%).

Table 4.
Parameters Related to Operative Complications

	With Complications (n = 28)	No Complications (n = 145)	P value
Age	46.9 ± 5.8 (40–72)	45.2 ± 4.6 (25–56)	0.09
BMI	23.3 ± 2.5 (18.5–27.9)	23.9 ± 4.0 (16.8–35.1)	0.45
Leuplin treatment before operation	10 (35.7)	29 (20.)	0.12
History of previous surgery	15 (53.6)	47 (32.4)	0.06
LSH type of operation	4 (14.3)	30 (20.7)	0.60
Combined additional procedures	7 (25.0)	18 (12.4)	0.15
Pelvic adhesion	12 (42.9)	28 (19.3)	0.01
Uterine weight, g	631.6 ± 321.3 (160–1523)	413.2 ± 219.3 (113–1078)	<0.001
Operative time, min	206.3 ± 81.5 (93–390)	137.4 ± 47.1 (72–310)	<0.001
Estimated blood loss, mL	728.6 ± 483.7 (50–2300)	157.7 ± 153.7 (20–800)	<0.001
Hospital stay, days	4.5 ± 3.9 (3–20)	3.0 ± 0.2 (2–4)	<0.001
Operative sequence	90.9 ± 46.3 (8–171)	86.3 ± 50.9 (1–173)	0.66

BMI, body mass index; LSH, laparoscopic supracervical hysterectomy.

ported that the operative time in SPH was similar that in MLH,¹⁵ which suggested that SPH is as feasible as MLH when performed by well-trained laparoscopists after a large volume of SPH. There were few reports on SPH in a large uterus. An early study on initial experience with SPH in a uterus > 500 g showed a linear correlation of operative time with extirpated uterine weight and a requirement for additional ancillary ports in 2 of 15 cases.¹⁶ You et al. studied SPH in LSH, where 32% of uteri were ≥ 500 g, and reported that more ancillary ports were necessary during their initial cases.¹⁴ We reported our initial experience of SPH in difficult large barrel-shaped uteri after GnRHa treatment. We found operative time in such

cases correlated parallel to uterine weight, and ancillary ports were required in 2 cases.

Several strategies have been applied to overcome the difficulty of minimally invasive surgery for a large uterus, such as myomectomy followed by hysterectomy, direct morcellation after uterine artery ligation,¹⁷ in situ morcellation using power morcellator,⁹ 4 trocar methods,¹⁸ and the vaginal “paper roll” uterine morcellation technique.¹⁹ Among these strategies, power morcellator was no longer a custom clinical practice. The application of GnRHa before surgery to reduce uterine and fibroid size for more feasible abdominal hysterectomy was known for many

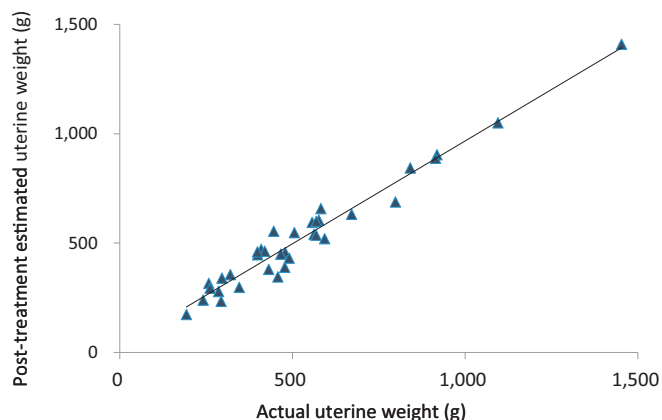


Figure 1. Scatter plot of actual uterine weight against post-treatment estimated uterine weight in patients with GnRHa treatment.

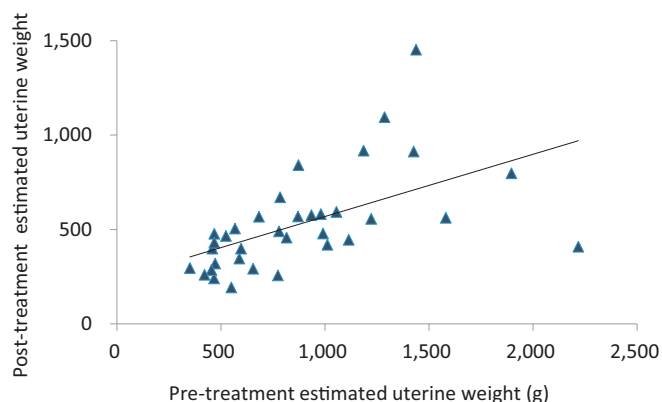


Figure 2. Scatterplot of estimated uterine weight before and after treatment in patients with GnRHa treatment.

years.⁷ In the Leuprolide Study Group, uterine volume was reported to decrease by 36% at 12 wk and 45% at 24 wk after leuprolide therapy.²⁰ Other GnRHs, such as triptorelin, were equally effective and could reduce uterine volume by 26.5% when uterine sizes were of 16 to 20 gestational weeks.²¹ Treatment effects of GnRHa could be due to different regimens and amounts of GnRHa used, errors in estimation of uterine size, and variation in pre-treatment fibroid sizes. In our study, we used sonography to estimate uterine weight before and after GnRHa (leuprolide acetate depot) treatment and found a 40.6% decrease in uterine volume after an average of 3.2 doses (12.8 wk) of GnRHa. In addition, although most our patients had leiomyoma, we found adenomyosis responded more effectively to GnRHa treatment.

The effect of GnRHa treatment to decrease uterine size might not be effective in some conditions. Furui et al.

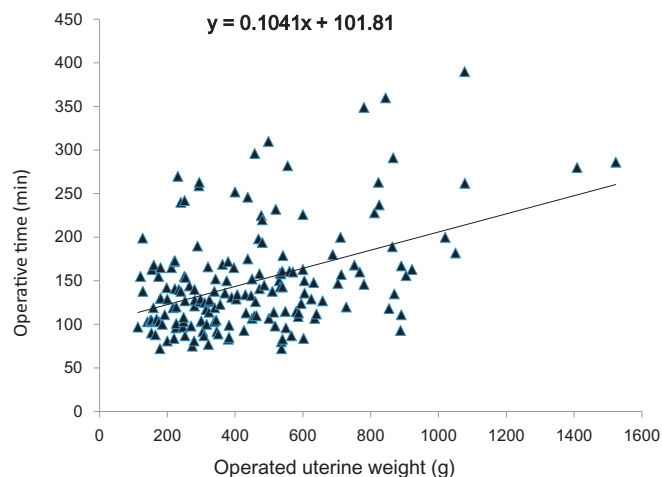


Figure 3. Scatterplot of operative time against uterine weight.

reported ineffective treatment results in pedunculated, degenerated, or cervical myomas after 20 wk of GnRHa treatment, despite a 63% reduction in submucous, intramural, or subserous fibroids.²² In our study, a large intraligamentous myoma, which was not recognized before treatment, was unresponsive to 12 wk of GnRHa treatment. An ancillary port was required for in situ morcellation, and the operation was complicated with massive bleeding and ureter injury.

In our study, we observed a higher rate of urinary tract injury in the GnRHa treatment group compared with the control group. The urinary tract injury rates were reported to be 4.3% to 4.8% in hysterectomy²³ and 0.7% in laparoscopic hysterectomy.²⁴ Park et al. reported 4 cases (0.8%) of urinary tract injuries in their 515 cases of SPH.²⁵ Various techniques have been applied to avoid urinary tract injury during minimally invasive hysterectomy, such as ureter tract identification during surgery,²⁶ use of uterine manipulator during uterine arterial coagulation, preventive placement of ureter stents,²⁶ and intraoperative cystoscopy.²⁷ We did not perform intraoperative cystoscopy and ureter stenting in all of our cases. Intraoperative cystoscopy could detect approximately 50% of urinary tract injuries during hysterectomy but has limited accuracy and was reported to be ineffective in decreasing delayed post-operative complications.²⁷ The application of ureter stent to prevent urinary tract injury was not supported in benign gynecological surgeries.²⁸ We used a uterine manipulator (Valtchev uterine mobilizer) in all our cases. This uterine manipulator was not effective enough to push ureters aside during uterine arterial coagulation and cutting. Identification of bilateral ureters was strongly recommended in a large uterus to prevent ureter injury. However, identifi-

cation of ureters in a distorted uterus is difficult due to limited parametrial spaces. We modified our procedure by dissecting the broad ligament between uterus and bladder junction to create a wide window between the bladder and the uterine artery. And then we pushed up the uterine manipulator in caudal direction. In this manner, the uterine artery was pushed up and the ureter was anatomically descended and moved away from the uterine artery for safe coagulation and cutting of the uterine artery. Yet, the higher rate of urinary tract injury in the GnRHa treatment group suggested that distorted anatomy of “barrel-shaped” uteri after GnRHa treatment remains at higher risk for safe surgery.

A patient in the control group had the complication of rectal perforation during SPH. She had adenomyosis with complete cul-de-sac obliteration. The limitation of inline vision in single port surgery in the hands of an inexperienced surgeon could have caused this complication. Her rectal perforation was repaired laparoscopically in consultation with a colon surgeon.

One of the major limitations of our study is that only a single surgeon from a single institute was included. However, study from 1 surgeon could give uniformity of methodology and technique. Other limitations of our study include difficulty of providing a clear definition of a barrel-shaped uterus, lack of randomization, and small patient number in a long study period. The definition of barrel-shaped uterus was based on pelvic examination, which was rather examiner and patient dependent. There are no measurable parameters to define such a uterus. Randomization is inappropriate because SPH in barrel-shaped uteri without GnRHa treatment is impossible according to the surgeon’s experience. Cases that met the definition of barrel-shaped uterus were few, and therefore a long study period was needed to accumulate an adequate number of patients for the study. Due to such a long study period, the learning curve could have involved and therefore cases without GnRHa treatment during the study period were included as controls. The strength of our study is that we have many patients with a barrel-shaped uterus; 22.5% of our patients included in the study period had a barrel-shaped uterus. Most of these patients were referred from local hospitals and showed a willingness to receive GnRHa before SPH.

Our study had a complication rate of 10.3% for bladder injury and a mean hospital stay of 3.7 d in the treatment group, which were higher than literature reports. High surgical volume is known as a major factor related to a lower complication rate.^{26,13} Although we found surgical

complication unrelated to our operative sequence, SPH in barrel-shaped uteri after GnRHa treatment could still be difficult and requires more surgical volume to avoid complications. With a longer study period and more such cases, we might be able to observe a further decline in complication rates.

Prior abdominal surgery and previous cesarean section are the 2 other major factors reported to be related to urinary tract complications in MLH.²⁵ In our study, complications were related to larger uterine weight as well as to a history of previous surgery and pelvic adhesion. Cases with complications were associated with longer operative time, greater EBL, and longer hospital stay. Interestingly, our study showed a similar incidence of pelvic adhesion and uterine weight between the 2 groups of patients, yet GnRHa treatment was unrelated to complications. We still believe that even after GnRHa treatment the anatomically distorted “barrel-shaped” uterus could be a key factor for such complications. Additional efforts during surgery in these cases were required to create an effective distance between uterine arteries and the ureter for coagulation and cutting of uterine arteries. Informed consent should be given and emphasized given the higher rate of urinary tract injuries in these cases.

Power morcellators were used in 2 cases in the early period of our study when power morcellation had not yet been prohibited. Both cases were poor responders to GnRHa treatment and were too difficult for SPH without morcellation being performed before hysterectomy. In all other cases, uteri were extracted from the vagina or umbilical wound via scalpel or scissors. We did not use bag tissue extraction in these cases. No uterine malignancies were found in our study. Uterine sarcoma is theoretically unresponsive to GnRHa treatment. Cases unresponsive to GnRHa should be carefully informed for the risk of uterine sarcoma, apart from the difficulty of SPH.

Another benefit of GnRHa treatment is the improvement in anemic condition before surgery. The average increase in hemoglobin level was reported to be 1.3 g/dL after preoperative GnRHa treatment.⁷ Our study showed an increase of 3.0 g/dL in hemoglobin level after GnRHa treatment. We have a relative hemoglobin improvement because 35.6% of our cases were anemic before GnRHa treatment. However, 2 of our cases were complicated with unexpected massive bleeding during GnRHa treatment that required blood transfusion before surgery.

Premature termination rate was reported to be around 8% in the Leuprolide Study Group.¹⁹ Two of our patients were intolerant to the hypoestrogenism side effects and re-

quested immediate operation after a single dose of GnRHa treatment that was ineffective for uterine volume reduction. Operations were found to be difficult in these 2 cases, and 1 patient was complicated with massive bleeding during operation. Before treatment, patients should be informed about premature termination of GnRHa treatments with possible massive bleeding and inadequate size reduction that could cause surgery to be difficult.

The benefits of decreasing operative blood loss and operative time after GnRHa treatment were controversial in abdominal hysterectomy.⁷ A meta-analysis that included all randomized controlled trials of the use of GnRHa before abdominal hysterectomy suggested that GnRHa treatment was not recommended during the waiting time for abdominal hysterectomy.²⁹ However, in MLH, a randomized prospective study showed that a reduction of uterine volume in 26.5% after 3 mo of GnRHa treatment in a large uterus (> 14 wk) could significantly reduce operative time and could preclude conversion.²¹ In SPH, a strategy of gasless method in large uteri weighing \geq 500 g showed a significant positive linear correlation between the operative time or EBS and the extirpated uterine weigh after GnRHa pretreatment.³⁰ In our study, we did not observe the difference in blood loss with GnRHa treatment. However, by comparing patients with and without GnRHa treatment and using ultrasound measurements to estimate the decrease in uterine weight due to GnRHa treatment, we could observe the decrease in uterine weight and calculate an average 34-min shortening of operative time after GnRHa treatment. And, more importantly, these patients had large, “barrel-shaped” uteri and were potentially inoperable before GnRHa treatment.

CONCLUSION

Our study supported GnRHa treatment before SPH in large barrel-shaped uteri. After treatment, reduction in uterine weight could be reflected in the improvement of anemia, decrease in uterine size, and shortening of operative time. However, complications in such cases were high and warrant special attention.

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